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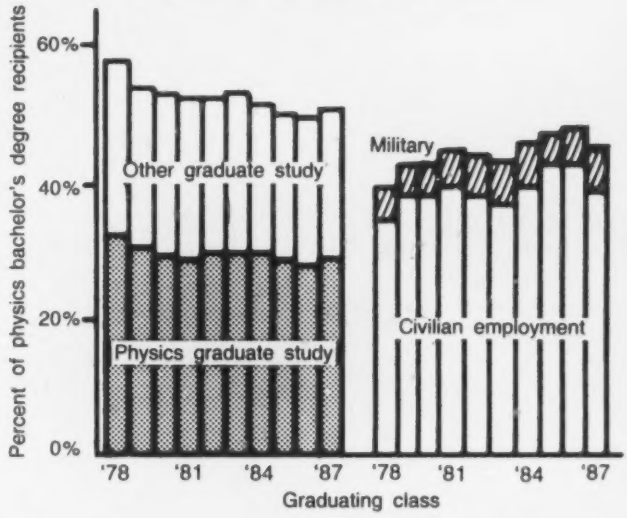
1986–87 SURVEY OF PHYSICS AND ASTRONOMY BACHELOR'S DEGREE RECIPIENTS

Although the choice of a hard science as an undergraduate major constitutes an excellent preparation for a variety of careers, most students have a specific post-degree plan in mind and tailor their course work to that plan. A detailed look at the postbaccalaureate plans of 2800 new physics and 100 new astronomy bachelors is the focus of this report; it is based on the graduates of the class of 1987. All the information comes directly from the individual degree recipients, who comprise 53% of the actual number of new physics and astronomy bachelors. Because this annual survey dates back to the 1960s, current data can be compared with those of earlier years to reveal trends that show significant changes. Highlights of the information presented in this report are:

- ➤Undergraduate enrollment is shifting from private to public institutions.
- ➤The job market for physics bachelors declined for the second year in a row.
- ➤Military service has become the fastest growing employment category for new physics bachelors.

Figure I. Trends in postbaccalaureate plans of physics bachelors, 1978–1987.



For several years various publications have discussed the anticipated increase in the demand for physicists; consequently one might expect to observe small changes in the postbaccalaureate plans of physics bachelors who are influenced by those projections. The graduates in the class of 1987, when added to the trend data shown in **Figure I** and **Table I**, appear to indicate a slight shift toward graduate studies and away from immediate employment. Our interpretation of this shift is based on the widely accepted definition that a physicist is a person with at least a master's degree in physics and typically a physics doctorate. Therefore the bachelors who reported acceptance into a graduate physics program can be presumed to be the most likely candidates for careers in physics. Furthermore, the group reporting "other graduate study" by and large refers to disciplines closely related to physics. A third group that can be viewed as "potential physicists" pursues a somewhat longer approach to a career in physics: approximately 200 graduates each year interrupt their studies for a year or two in order to try full-time employment and subsequently immerse themselves in a physics doctoral program for five or six years. The recent gradual increase in the proportion of new physics bachelors who enter the military service generally points to a poorer job market at that level.

Table I. Postbaccalaureate plans of successive graduating classes of physics bachelors, 1977–1987.

Postbaccalaureate plans	1977–78	1978–79	1979–80	1980–81	1981–82	1982–83	1983–84	1984–85	1985–86	1986–87
Physics graduate study	33%	31%	30%	29%	30%	30%	30%	29%	28%	29%
Other graduate study	26	24	24	24	23	24	22	21	21	22
Civilian employment	34	38	38	39	38	36	40	43	43	39
Military service	5	5	5	6	7	8	6	5	6	7
Undecided	2	2	3	2	2	2	2	2	2	3
Total number of physics bachelor's degrees	4457	4416	4440	4513	4558	4795	4878	5188	5214	5253

Table II. Characteristics of new physics bachelors, 1986–87.

Characteristics		Postbaccalaureate plans: Graduate study – Physics	Graduate study – Other	Employment	Undecided	Total
Sex	Female*	13%	19%	16%	17%	16.1%
	Male	87	81	84	83	83.9
Citizenship	U.S.	92%	94%	97%	92%	94.9%
	Foreign	8	6	3	8	5.1
Age	20 or younger	1%	1%	–	–	0.6%
	21	6	3	3%	8%	4.1
	22	47	48	36	39	42.1
	23	21	27	24	18	23.4
	24–27	16	15	23	22	18.6
	28 or older	9	6	14	13	11.2
Minority groups	U.S. blacks	1.8%	1.5%	2.4%	4.5%	2.1%
	Other U.S. minor.	6.7	5.8	5.7	7.9	6.1
	Foreign minor.	6.2	4.5	1.7	6.8	3.8
Transferred from junior college	Yes	9%	5%	12%	16%	9.7%
	No	91	95	88	79	90.3
Double major	Yes	27%	38%	25%	21%	29.0%
	No	73	62	75	79	71.0
Type of undergraduate institution	Public	59%	50%	65%	56%	60.0%
	Private	41	50	35	44	40.0
	PhD-granting	55%	46%	43%	43%	47.1%
	MS-granting	12	9	14	10	12.5
	BS/BA-granting	33	45	43	47	40.4
Total number of bachelors		1545	1132	2411	165	5253
% distribution		29%	22%	46%	3%	100%
Number of respondents		824	604	1286	88	2802

**Percentage of women was adjusted for differential response rate.*

A description of new physics bachelors in terms of their characteristics is more meaningful when the graduates are divided into groups according to their postbaccalaureate plans. **Table II** illustrates this statement by listing seven characteristics and showing their variations with respect to the four groups of physics bachelors. The greatest differences occur between the employment group and the other three. Employment-oriented bachelors include the lowest proportion of foreign graduates; they are older and are more likely to have transferred from a junior college.

The much-publicized increases in tuition at private institutions prompted us to look for changes in degree production that may have occurred since the early 1980s. By comparing the physics bachelors in the class of 1987 with those who graduated in the class of 1982 we find that the 60:40 ratio of public to private institutions shown in **Table II** represents a five percentage-point shift away from the private institutions. A more detailed analysis of this characteristic shows that private institutions graduated a disproportionately small number of employment-oriented physics bachelors. Other comparisons of characteristics with those of earlier years point to increases in the proportion of U.S. minorities among all physics bachelors in the class of 1987 and increases in the proportion of women in the group that chose "other graduate study".

Further differences between graduates from public and private institutions can be found when we examine their educational backgrounds. We find that only 6% of the graduates from private institutions, compared with 17% of the public college graduates, did not take a high school physics course. **Table III** makes these comparisons and lists the types of high school physics courses taken by these two groups of physics bachelors.

Table III. A comparison of the high school physics backgrounds between 1986–87 physics bachelors from public and private institutions.

Type of high school physics†		Undergraduate institution: Public	Private	Total: N	%
PSSC*		7%	9%	206	8%
Project physics		5	5	115	5
AP physics		9	20	348	14
General physics		62	60	1529	61
None		17	6	302	12
Total respondents	%	100%	100%		100%
	N**	1328	1172	2500	

† In 1987 the high school physics categories of this question were revised so as to achieve a higher response.
**PSSC = Physical Science Study Committee*
***Nonrespondents to the question = 302*

Table IV. Postbaccalaureate plans of U.S. and foreign minorities among the physics bachelors of the class of 1987.

Minorities	Postbaccalaureate plans: Graduate study, Physics	Graduate study, Other	Empl.	Total %	Total N
U.S. blacks	25%	15%	60%	100%	60
U.S. Orientals	34	21	45	100	99
Other U.S. minorities	29	21	50	100	66
Total U.S. minorities	30%	20%	50%	100%	225
Foreign Orientals	51%	25%	24%	100%	49
Other foreign minorities	46	26	28	100	57
Total foreign minorities	48%	26%	26%	100%	106
All respondents	29%	22%	49%	100%	2802

Having demonstrated in **Table II** how the characteristics of a composite group can differ significantly from those of its component parts, we apply a similar analysis in **Table IV** to the minority students among the physics bachelors. To present an accurate picture we separate the foreign minorities because their legal status in the U.S. makes them ineligible for regular employment and thereby biases the distribution of their postbaccalaureate plans. The combined plans of all U.S. minority respondents were similar to those of all respondents; however, the plans of U.S. blacks are more employment oriented while U.S. Orientals appear to favor graduate study in physics. We presume that the U.S. Orientals increased significantly because the number of respondents rose from 60 to 99 in one year.

Additional details on minorities are provided in **Table V**, which lists six distinct minority groups and the numbers of physics bachelors who identified themselves with each group. The larger groups that are neither predominantly foreign nor predominantly U.S. are divided on the basis of citizenship, thereby showing that U.S. blacks continue to include a relatively high proportion of women and that they concentrate in the four-year colleges. Orientals, on the other hand, tend to choose PhD-granting institutions for their undergraduate studies irrespective of their citizenship.

Table V. Selected characteristics of minority physics bachelors, 1987.

		Minority group: Black U.S.	Black Foreign	Native American Indian	Hispanic U.S.	Hispanic Foreign	Oriental U.S.	Oriental Foreign	Asian Indian	Arab
	Total	60	9	5	40	12	99	49	26	31
Sex	Female	20	1	1	6	–	18	10	7	5
	Male	40	8	4	34	12	81	39	19	26
Age	21 or younger	4	–	–	2	1	6	4	5	4
	22	13	2	3	11	2	42	10	10	4
	23	15	1	2	6	2	20	13	3	9
	24	9	–	–	9	2	11	8	2	4
	25–27	7	2	–	5	3	9	6	1	6
	28 or older	12	4	–	7	2	11	8	5	4
Region* of bach's inst.	Northeast	7	1	1	5	5	28	11	13	6
	Southeast	33	5	–	5	3	5	7	2	1
	Central & Mountain	18	3	2	14	2	25	15	7	17
	Pacific	2	–	2	16	2	41	16	4	7
Type of bach's inst.	PhD-granting	15	1	1	22	10	70	29	14	17
	MS-granting	8	–	–	6	–	6	4	1	7
	BS/BA-granting	37	8	4	12	2	23	16	11	7

**Regions: Northeast = New England, Middle Atlantic; Southeast = South Atlantic, East South Central; Central = East North Central, West North Central, West South Central.*

Table VI. Sources of anticipated support for first-year graduate study*, 1985–87.

Sources of support		Students planning: Physics graduate study 1985	1986	1987	Other graduate study 1985	1986	1987
Teaching assistantship		49%	51%	52%	16%	19%	16%
Research assistantship		10	10	12	16	14	15
Fellowship		13	11	12	16	12	18
Family, savings, loan		6	4	5	27	22	23
Employment (part-time)		2	4	2	11	11	10
Other		2	6	3	5	9	5
Multiple	TA/RA	7	6	8	4	7	5
	TA/Fellowship	5	5	4	2	4	1
	TA/Family, savings, loan	6	3	2	3	2	7
		100%	100%	100%	100%	100%	100%
Graduate study status	full-time	91%	91%	92%	75%	81%	81%
	part-time	9	9	8	25	19	19
Total number of full-time students		1484	1455	1545	1110	1100	1132

**The information was reported for September of each academic year.*

The major sources of support available to bachelors who enter graduate programs fall into two broad categories: (1) assistantships and fellowships funded by the universities or government agencies, and (2) funds provided by the students such as family savings, loans or part-time employment. The proportions in which these sources of support are offered to two groups of physics bachelors differ significantly from one another as shown in **Table VI**. For example, teaching assistantships constitute not only the most common type of support for those who become graduate physics students, but also the only source of support for half of that group. Physics bachelors who enter other disciplines of graduate study find fewer teaching assistantships available and a greater proportion of them needs to use personal funds, 35% in contrast to only 7–8% of those entering graduate physics programs.

The lower portion of **Table VI** is based on a slightly larger group of new physics bachelors because it includes those who have accepted full-time employment and pursue graduate studies on a part-time basis. Again we call attention to the difference between the two groups of graduate students: In physics the part-time students comprise less than 10% whereas those who entered "other graduate study" included almost 20%.

Either postponing or ignoring the graduate study necessary to become a physicist appears to be a trend that has increased in popularity over the decades. For example, civilian employment as a postbaccalaureate plan was chosen by one-quarter of the physics bachelors in the 1960s, by one-third of them in the 1970s and by almost half of them in the 1980s. Consequently, analyzing the demand for physics graduates at that level is an important part of this survey. To accomplish that we ask each employment-oriented bachelor for the number of job offers he or she received, which provides us with a scale of no offers, one offer and multiple offers. **Table VII** presents these data consecutively for the most recent five years and adds 1980 and 1975 for comparison purposes. It is important to state that "zero job offers" refers to the time immediately following graduation and should not be mistaken for a general unemployment rate. Thus an overall evaluation of the demand for physics bachelors points to a decline in terms of decreasing percentages of graduates who reported multiple job offers to choose from.

A comprehensive view of the four groups of physics bachelors defined in **Table I** is presented in **Figure II**. Specific details describing the plans or current activities of each group are outlined in this flow diagram. For example, the major disciplines chosen by the graduate students who intended to enter "other graduate study" are listed and the employment-oriented group is divided into categories that distinguish between firm commitments and uncertain plans. Changes from the previous year involved decreases among those who are "continuing civilian employment" and those who are "employed but seeking", while the "uncommitted" group registered a three percentage-point increase. At the same time, graduates who had accepted new positions in the civilian sector did not show an appreciable increase. Thus we interpret these changes to suggest a less favorable job market, which has invited some shift into graduate studies.

Table VII. Changes in employment outlook for new physics bachelors, 1975–1987.

Number of job offers at graduation	Summer 1975	Summer 1980	Summer 1983	Summer 1984	Summer 1985	Summer 1986	Summer 1987
0	17%	10%	11%	13%	14%	13%	15%
1*	56	50	58	54	59	66	68
2 or more	27	40	31	33	27	21	17

**Bachelors who enter the military service are included here.*

Figure II. Postbaccalaureate plans of physics bachelors of the class of 1987.

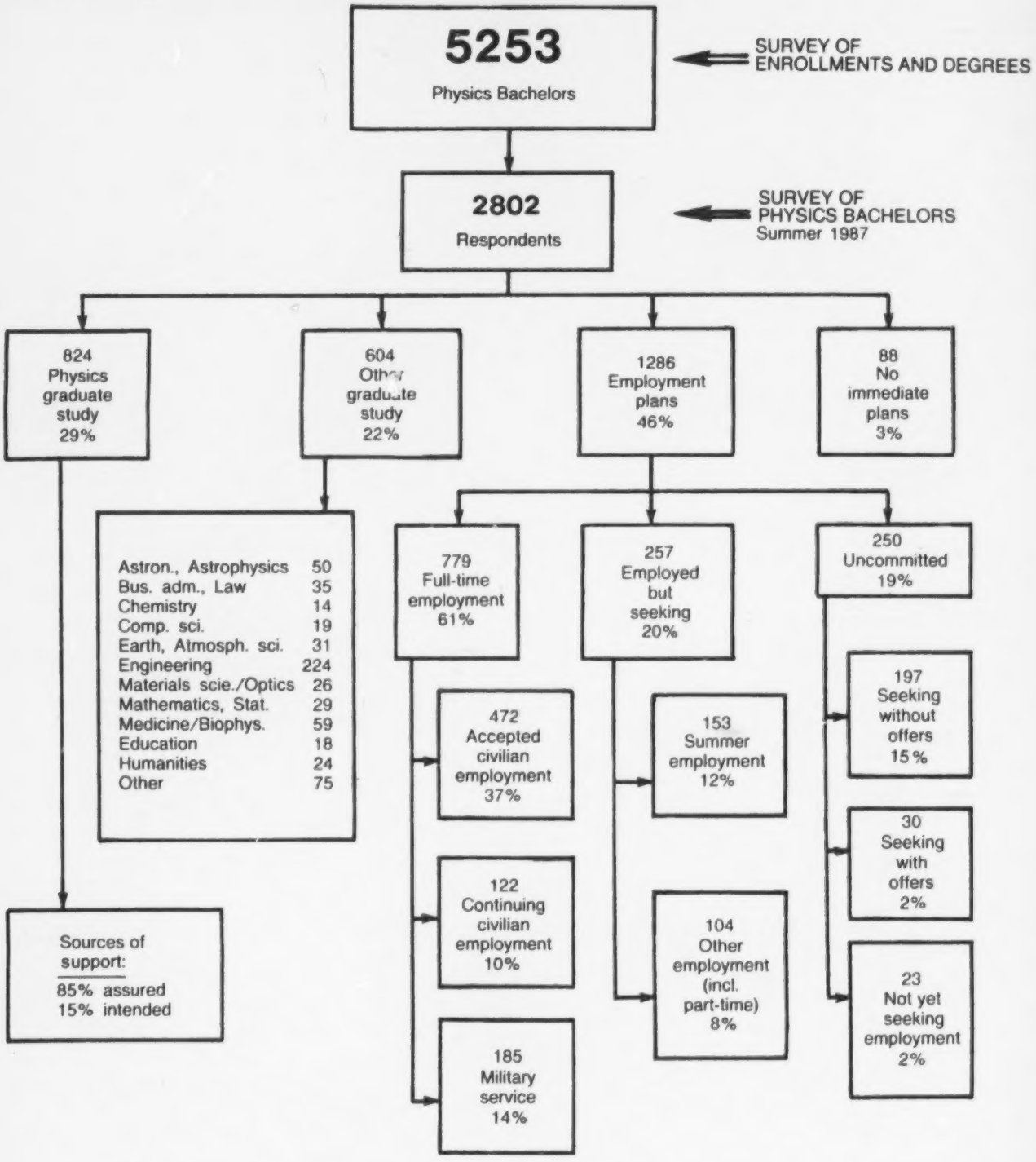


Table VIII. Initial employment of physics bachelors, 1977–87.

Type of employer	Percentage of employed bachelors									
	1977–78	1978–79	1979–80	1980–81	1981–82	1982–83	1983–84	1984–85	1985–86	1986–87
Industry {manufacture	37%	40%	41%	40%	38%	33%	38%	35%	30%	28%
Industry {service	21	18	20	22	22	20	16	20	18	18
High school	7	6	3	2	3	4	4	4	7	6
College or university	3	4	3	4	4	4	5	3	4	4
Government {civilian	7	7	8	7	7	10	12	14	13	11
Government {military	14	15	16	21	24	27	24	23	28	32
Other	11	10	9	4	2	2	1	1	–	1
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

From the distribution of initial employers reported over a ten-year period by successive graduating classes of physics bachelors, two distinct trends emerged: (1) the steady decline, since 1980, of industrial manufacturing jobs, and (2) a substantial increase in the proportion of bachelors who entered the military service each year. The former is a reflection of the U.S. economy as a whole, which has begun to lose manufacturing jobs; the latter calls attention to how attractive the military service has become. Specialized training, such as pilot training or enrolling in a nuclear power school, was mentioned frequently by those bachelors who identified themselves as members of the R.O.T.C. Graduates from the three military academies (in Annapolis, Colorado Springs and West Point) were uncertain about their assignments. Another trend evident from the data of **Table VIII**, is the relatively constant proportion of physics bachelors whose employment we categorize as service industry. The qualifications necessary for that type of employment consist largely of a technical or mathematical orientation rather than the specific training physics bachelors received.

The range of median salaries paid by different types of employers decreased between 1986 and 1987. **Table IX** indicates a range of $870/month, from $1480 to $2350/month, down from a $950 range in the previous year. The overall median salary computed for 1987 reflects a decrease for the second year in a row, making it equal to the median reported by the class of 1984. Factors contributing to the lower median include the shift from industry to the military as well as an almost 10% decline in the median salary paid by civilian government agencies and an 11% decline in service industry salaries.

Since the early 1980s employers in most areas offered higher salaries to women than men with new physics bachelor's degrees; the class of 1987 introduced a change in this trend. For example, service industries, high schools and the government appeared to offer lower paying positions to women graduates as shown in **Table IX**. The highest salaries paid to men or women are those paid by industrial defense contractors. Approximately 100 degree recipients in 1987 accepted those positions and their median salary was $2400 per month.

The employment-oriented graduates of **Figure II** include 122 bachelors who had decided to remain with employers for whom they worked before receiving their bachelor's degrees. This groups had been excluded from **Tables VIII** and **IX** because these degree recipients did not seek employment in 1987 and their salaries were generally higher. However, **Table X** includes the group described as "continuing civilian employment" because its members hold full-time potentially permanent positions whose work activities and employers are of interest. The last two rows of **Table X** indicate that most of the new bachelors perceive their employment as making use of their physics training; the exceptions are the bachelors in service industries, where only half of them utilize their training.

Table IX. Starting salaries of physics bachelors, 1987.

Type of employer	Men (385 reported salaries)		Women (87 reported salaries)		Total (472 reported salaries)	
	Dist. by employer	Median monthly salary	Dist. by employer	Median monthly salary	Dist. by employer	Median monthly salary
Industry {manufacture	29%	$2340	27%	$2400	28%	$2350
Industry {service	16	1960	26	1750	18	1920
High school	5	1550	12	1470	6	1510
College or university	4	1480	2	**	4	1480
Government {civilian	8	1835	13	1600	9	1670
Government {military	35	1630	14	**	32	1610
Fed. Fund. Res. Ctr.	2	2150	3	**	2	2330
Other	1	1830	3	1740	1	1780
Total	100%	$1890	100%	$1830	100%	$1870

***Insufficient data.*

Table X. Full-time employment* of new physics bachelors, 1987.

Work activity		Type of employer: Industry manufacture	Industry service	High school	Government civilian	Government military	Coll. univ.	Other	Total N	Total %
Teaching		–	–	33	11	–	5	1	50	7%
Research & development		40	11	1	16	87	19	3	177	24
Development & design		133	29	–	26	6	7	2	203	28
Programming		29	37	–	16	3	5	1	91	12
Specialized training**		3	7	–	4	85	1	–	100	14
Marketing		8	13	–	1	–	–	–	22	3
Other professional work		7	28	–	3	3	4	6	51	7
Other		10	23	–	4	1	1	–	39	5
Total	N	230	148	34	81	185	42	13	733	
	%	31	20	5	11	25	6	2		100%
Using physics training	Yes	93%	53%	100%	92%	90%	95%	73%		83%
	No	7	47	–	8	10	5	27		17

The employment of these 733 graduates includes both newly accepted positions as well as those in which graduates are continuing. Excluded are graduates in temporary and summer employment.

***Training paid for by the employer includes pilot navigator training by the military.*

ASTRONOMY

The new astronomy bachelors of the class of 1987 comprise less than 4% of the physics degree recipients for that year, making comparisons of characteristics less appropriate. However for this graduating class both the proportion of women and foreign students are almost identical to those of the physics bachelors. The survey of astronomy bachelors yielded 91 respondents whose characteristics are related to their postbaccalaureate plans in **Table XI**. The total number of astronomy bachelor's degrees was reported by the sixty colleges and universities that offer an undergrad-

Table XI. Characteristics of astronomy bachelors, 1987.

Characteristics		Postbaccalaureate plans: Graduate study Astronomy N	Graduate study Other N	Employment N	Undecided N	Total %
Sex	Female	6	4	4	–	15%
	Male	40	9	27	1	85
Citizenship	U.S.	42	12	31	1	95%
	Foreign	4	1	–	–	5
Type of high school physics**	PSSC*	3	2	1	–	7%
	Project physics	2	1	1	–	5
	AP physics	7	2	6	–	18
	General physics	27	8	17	1	63
	None	2	–	4	–	7
Age	21 or younger	1	–	–	–	1%
	22	26	8	13	–	51
	23	9	3	10	–	24
	24	5	1	6	–	13
	25 or older	5	1	2	1	11
Type of bachelor's institution	PhD-granting	36	7	25	1	76%
	MS-granting	2	–	1	–	3
	BS/BA-granting	8	6	5	–	21
Type of degree	Science	30	7	20	1	64%
	Arts	16	6	11	–	36
Double major	Yes	14	7	16	1	42%
	No	32	6	15	–	58
Total respondents		46	13	31	1	91
Total number of astronomy bachelors		87	24	59	2	172

PSSC = Physical Science Study Committee.

***There were 7 nonrespondents to this question.*

Table XII. Postbaccalaureate plans of successive graduating classes of astronomy bachelors, 1977–87.

Postbaccalaureate plans	1977–78	1978–79	1979–80	1980–81	1981–82	1982–83	1983–84	1984–85	1985–86	1986–87
Astronomy graduate study	33%	28%	35%	24%	29%	38%	38%	35%	40%	51%
Other graduate study	22	19	17	13	25	17	31	18	16	14
Employment	40	51	43	59	45	41	28	44	38	34
Undecided	5	2	5	4	1	4	3	3	6	1
Total number of astronomy bachelors	177	165	165	156	181	138	137	145	169	172

uate astronomy degree. Most of these institutions also have a doctoral programs, which accounts for the high proportion of astronomy bachelors who graduate from PhD-granting schools. Looking back at the early 1980s we find in **Table XII** that immediate graduate study is the postbaccalaureate plan of a majority of astronomy bachelors, and an increasing proportion of them are now entering graduate study in astronomy.

The unfavorable job market mentioned in connection with the physics graduates carries over to the astronomy bachelors where **Figure III** indicates that 9 of the 31 employment-oriented bachelors appear to encounter some difficulty in finding suitable employment. A majority of those who chose "other graduate study" entered graduate physics programs, as might be expected.

This report was prepared with the help of Patrick J. Mulvey and Mark C. Didriksen.

Figure III. Postbaccalaureate plans of astronomy bachelors of the class of 1987.